VANADIUM CORPORATION OF AMERICA SKIMMER
(VCA) NATURITA MILL, STEEL ~~SKINNER~~ SALT ROASTER
approximately three miles northwest of Naturita,
between Colorado State Highway and
the San Miguel River
Vicinity of Naturita
Montrose County
Colorado

HAER No. CO-81-G

HAER
COLO
43-NATU.V
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PHOTOGRAPH

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
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HISTORIC AMERICAN ENGINEERING RECORD

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VANADIUM CORPORATION OF AMERICA (VCA) NATURITA MILL, STEEL ~~SKINNER~~ SKIMMER SALT ROASTER HAER No. CO-81-G

Location: In northwest quadrant of mill complex, immediately southwest of Steel Skinner Salt Roaster, approximately three miles northwest of Naturita, between Colorado State Highway 141 to the southwest and the San Miguel River to the northeast; in the NW1/4 of the SW1/4 of Section 14, Township 46 North, Range 16 West

Date of Construction: Circa 1941, moved 1947

Designer: L. B. Skinner Company

Builder: Original builder unknown; moved and rebuilt at VCA Naturita Mill site by VCA employees in 1947

Present Owner: Cyprus-Amax Minerals Corporation, 9100 E. Mineral Circle, Englewood, CO, 80112

Present Use: Vacant / Not in Use

Significance: Moved from Dry Valley, Utah and reconstructed at the Naturita Mill in 1947, this structure and the other remaining roaster (Structure F) are among only four extant structures that remain from the uranium and vanadium milling that operated between 1947 and 1958. During the 1950s, when uranium and vanadium milling was at its peak, this was one of four roasters in operation at the Naturita site.

Processing the ore for its uranium and vanadium values during these years involved a series of steps that included, weighing, crushing, stockpiling, grinding, roasting, quenching and precipitating the final uranium and vanadium products. When the ore arrived at the mill it was allotted a serial number identifying who produced it and where it had been mined. It was then shoveled into stockpiles to await processing. A percentage of ore from each stockpile was shoveled into ore bins where it was blended to the proper consistency.[1] Next, the ore was drawn from the bottom of the bins into a jaw crusher which reduced the ore to minus ½-inch mesh.[2] This crushed material was then stockpiled in a another series of bins, before it was fed into a rod mill that pulverized the ore.[3] After it was pulverized, the ore was screened, and any oversized material was again put through the rod mill. This

finely ground ore was then put in storage bins to await the roasting process.

Two of the other three roasters in use at the Naturita Mill in the 1950s had been moved to the site from other locations. The other extant roaster was brought to Naturita from Dry Valley, Utah in 1947. One of the other two roasters, that is no longer standing, was obtained from the Bear Creek Mines and Mill, near Telluride, in the early 1950s, and the last roaster was obtained from a mill near Sparks, Nevada, also in the early 1950s. These two roasters were later moved to VCA's Durango Mill in 1958.

The roasters were approximately 17 to 20 feet in diameter, and between 30 and 34 feet in height. Their walls were built of fire brick, and one had an exterior steel shell. Each roaster had six levels (called "hearths"), separated from each other by brick partitions. A hollow steel shaft ran vertically through the center of each roaster, and within each hearth, two steel "roaster arms" were screwed into the center shaft. A series of raffles[4] (essentially steel paddles) were attached to the roaster arms, and together, the roaster arms and raffles revolved, raking, or raffling, the ore.

Before it was placed in the top of the roaster, the ore was mixed with seven percent salt and three percent iron pyrite. In the top hearth, the ore was raffled toward the roaster's middle, to an opening surrounding the center shaft, where it dropped down to the next hearth. In the second hearth, the ore was raffled outward to an opening at the roaster's perimeter. In the third hearth the ore was raffled back to the center, in the fourth hearth back to the perimeter, and so forth. As it passed through each hearth, the ore was roasted, eventually reaching a temperature of approximately 1500 degrees fahrenheit in the lowest hearth. To prevent the roaster's metal components from overheating, a high pressure blower was used to blow cool air through the hollow center shaft and roaster arms. In the 1940s, the roasters were fired by coal that was mined on the hillside across the river from the mill. In later years, the roasters were fueled by crude oil, propane, and finally natural gas.

The raffling process served to keep the ore in continuous motion, ensuring that it was uniformly exposed to the increasing temperatures. The overall purpose of the roasting operation was to create a chloride

gas that resulted from subjecting the ore, salt and iron pyrite mixture to the intense heat in the roaster.

When the ore came out of the roaster it was in the form of hot sand. This material was placed in quench tanks, approximately six feet in diameter and eight feet deep, with a filter mat in the bottom. Here, the ore was agitated with a solution of five percent soda ash. Next, the quenched ore was pumped to the leach section, where it entered large, 20-feet diameter by 12-feet deep, tanks. Here, the quenched ore percolated through a filter mat in the bottom of the tank, a process that took from 24 to 36 hours. When the quenching process was finished, a sludge like substance remained in the tanks, which was routed to the tailings pile. The liquid that passed through the filter mat contained both the uranium and vanadium values. Now referred to as a "high grade liquor" this material was pumped to an "A-Liquor" storage tank.

Also known as an "acid crack," the quenching and leaching processes served to separate (or crack) the uranium and vanadium from the outside of each sand particle. This separation was caused by a chemical reaction between the chloride gas that had been created in the roasting process and by quenching and agitating the ore with the soda ash solution.

From the A-Liquor storage tank, the high grade liquor was pumped to the uranium purification section where the uranium was largely separated from the vanadium and other insolubles. Here, the liquor was heated and mixed with acid until a nearly neutral Ph was attained. This liquor was then pumped through filter presses, and at this point, the uranium precipitated out into a soluble substance called "yellow cake." Consequently, the filtered liquor that passed through the filter presses still included the vanadium values, but no uranium values.

The uranium, or yellow cake, was then taken out of the presses and put in a drying oven. After it was dried, it was mixed with soda ash and sawdust and was placed in a fusion[5] furnace. Once it became molten, the liquid was drained into a water-cooled pan causing the fused liquid to turn into a solid, brittle, material. This material was placed in an agitator tank where it was again dissolved. Finally, this material was pumped into a large filter tank with an extremely fine filter mat. The material that failed to pass through the filter mat was 96 percent pure

uranium. The remaining four percent were insolubles including vanadium, copper and lime, which were then pumped to the vanadium precipitation section to extract the vanadium. The uranium was then packed into 55 gallon steel drums and shipped to the AEC in Grand Junction by truck.

In the meantime, the vanadium and other insolubles, still present in the "high grade" liquor were pumped to the vanadium precipitation section. The liquor was placed into one of five filter tanks. More acid was added until a Ph of 3.5 to 4 was achieved. In these filter tanks, a vacuum system helped to suck the waste liquid away, leaving the vanadium granules on the mat. Now known as "red cake", the vanadium was next shoveled into a bin with a large fusion furnace at the bottom. At the beginning of each work shift the furnace was filled with vanadium and fired. Using scoop shovels, it took two men an hour to charge the furnace. As the red cake melted, it began to fuse with the acids that had been added in the filter tanks.

As the fused, molten material puddled up in the bottom of the furnace, it was drained through a spigot onto a flaking machine. The flaking machine was a cast iron, water-enclosed, wheel approximately six feet in diameter. The wheel revolved horizontally below the spigot at the bottom of the fusion furnace.[6] When the molten liquid dropped from the spigot on to the water-cooled wheel, it instantly cooled and splattered into flakes on the wheel. This material -- the final vanadium product, called vanadium pentoxide -- was scraped off the wheel by a metal scraper and formed into 20-inch by 8-inch by 6-inch high cakes. The vanadium pentoxide was then sealed in 55-gallon steel drums and shipped from Naturita to Montrose by truck. From Montrose, the vanadium pentoxide was shipped by rail to Bridgeport, Pennsylvania, Cambridge, Ohio, or Keokuk, Iowa. It was then sold to various steel companies to be used as an alloy to give steel components greater tensile strength and elasticity.

General Description: The Steel Skinner Salt Roaster, the smaller of the two roasters still extant at the mill during field survey, was seventeen feet in diameter and nearly thirty feet high to the top of its shaft. Resting on six legs of steel "I" sections, the main cylinder of the Roaster was raised six feet above its concrete slab. A twenty-four inch diameter hollow steel shaft ran from its concrete pad on the concrete slab, vertically through the center of the cylindrical roaster.

The cylinder itself consisted of fire brick walls wrapped with steel sheathing and banding. The interior was divided into six "hearths", separated from each other by shallow brick domes. Each hearth level had openings, alternately, either near the shaft, or around the perimeter, by which ore would travel through the roaster from top hearth to bottom hearth. Four side-hinged metal doors, evenly spaced, opened onto each level.

Attached to the Roaster shaft by a metal "yoke" at each hearth level was a pair of opposing "rabble arms", which were the stirring mechanisms for each level. At the base of the shaft was a "wind box", which provided combustion air for the Roaster. A turning gear mechanism was located on a concrete pad west of the shaft. To the southeast was a rectangular brick furnace, the firing mechanism for the Roaster hearths. The northeast furnace was non-existent at the time of the field survey.

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[1] Among other factors relative to the ore's consistency, it was important that its lime content not be too high or too low. Otherwise, the ore would not react properly in the later stages of the milling process,

[2] A measurement of minus ½-inch mesh means that the individual granules of ore have a diameter of ½-inch or less.

[3] The rod mill at Naturita was comprised of a series of steel rods, three inches in diameter, and approximately six feet in length. The rods were turned by large, gear-driven, trunnions.

[4] Used either as a noun or verb, the term raffle means "rake."

[5] Used here, the term "fusion," from the root word "fuse", means to join together by melting.

[6] The flaking machine at the Naturita Mill was designed and built by VCA, but it was patterned after the "Burwell" designed flaking machine that was commonly employed at uranium and vanadium mills.